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# New groundnut varieties for smallholder farmers in Mpumalanga, South Africa

*C. MATHEWS[1], M. D. LENGWATI[1], M. F. SMITH[2] & S. N. NIGAM[3]*
[1]Department of Agriculture and Land Administration (DALA), Private Bag X 11318, Nelspruit-1200, South Africa.
cherian@laeveld1.agric.za
[2]Biometry Unit, Agricultural Research Council, Private Bag X519, Silverton-0127, South Africa
[3] International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India

**Abstract**: Groundnut (*Arachis hypogaea*) is a major food as well as cash crop for the smallholder farmers in Mpumalanga province of South Africa. The groundnut yield under smallholder environment is low due to several biotic and abiotic production constraints. Foliar diseases cause considerable yield reduction and chemical control is beyond the capabilities of the smallholder farmers. None of the groundnut varieties released in South Africa has resistance against the foliar disease complex of early leaf spot *(Cercospora arachidicola)*, late leaf spot *(Cercosporidium personatum)* and rust (*Puccinia arachidis)*. Studies to identify locally adapted foliar disease resistant varieties commenced in 1991 by DALA with the evaluation of elite lines obtained from ICRISAT. Although initial studies showed significant resistance to foliar diseases, the kernel yield of the varieties was significantly lower due to poor pod filling. 129 short-duration, drought resistant and foliar disease resistant elite lines / germplasm from ICRISAT were evaluated during 2000-04. Fifteen outstanding varieties from these were selected for further evaluation and this paper presents the performance of these varieties evaluated during 2004-2006 under the smallholder environment in Mpumalanga. The results from research-managed and farmer-managed trials across the province showed the yield potential of the foliar disease resistant variety ICGV98369. ICGVSM99529 selected for resistance to groundnut rosette disease in Malawi was the most outstanding followed by ICGV96294 among the short-duration and drought tolerant varieties evaluated. The information generated from this study is expected to enhance sustainability of smallholder cropping systems in Mpumalanga Province and similar environments across South Africa. The programme was funded by the Groundnut Development Trust, South Africa
**Key words:** *Foliar diseases, Groundnut development trust, ICRISAT, Sustainability*

## Introduction

Groundnut (*Arachis hypogaea* L.) is an important cash crop grown by commercial as well as smallholder farmers in South Africa (Swanevelder, 1994). It is produced commercially in the North-west, Free State and Northern Cape Provinces, and by smallholder farmers mainly in the Mpumalanga, Kwazulu-Natal and Limpopo Provinces (Van der Merwe, 1981). The average annual production in South Africa is around 100,000 tons (Swanevelder, 1998). The commercial sector is highly specialized and accounts for around 80% of the total annual area and production. Groundnut is the second most important crop grown by the smallholder farmers especially in the lowleveled and middleveld areas of Mpumalanga (Mathews and Beck 1994). Almost all the groundnuts produced by the smallholder farmers in Mpumalanga are used locally for home consumption (roasted, boiled etc.). Local sales are made at substantially high price and accounts for a significant part of farmer's income (Mathews and Beck, 1994). Major production constraints faced by these farmers are lack of locally adapted improved varieties, foliar diseases, drought at pod formation, poor agronomic practices followed and their social background (Mathews and Beck, 1994).

The foliar disease complex, to which most South African genotypes are highly susceptible, is a serious yield limiting factor to the smallholder farmers. Major components of the foliar disease complex are the early leaf spot (ELS) caused by *Cercospora arachidicola*, late leaf spot (LLS) caused by *Cercosporidium personatum* and rust caused by *Puccinia arachidis*, (Mathews and Beck, 1994; Van Wyk and Cilliers, 1998). The development of leaf spot is influenced by a complex of external factors (Porter *et al.*, 1984; Krantz, 1987; Swanevelder, 1998) and yield losses will vary between fields and seasons as a result of changes in these factors (Nutter and Shokes, 1995). Patil *et al.* (1978), for instance, reported no yield loss while Young *et al.* (1980), Cole (1982) and Subrahmanyam *et al.* (1995) reported yield losses of up to 80%. The yield reduction was estimated to be 9-89% in South Africa (Swanevelder, 1998) and up to 60% in Indonesia (Kano *et al.*, 1996). To control this disease complex, commercial farmers in South Africa rely on three rounds of fungicidal sprayings (Swanevelder, 1998) at a cost of R350 $ha^{-1}$ (US$50.00) per application. The application of fungicides for disease control is not a viable option for the resource poor, smallholder farmers. With the move towards sustainable agriculture in this country, multi-gene resistance provides the only means to control insect pests and diseases. Farmers require groundnut varieties with high and stable yield, high disease resistance and reasonable tolerance to drought. No such variety is currently available in South Africa. All the commercially available cultivars in South Africa were developed for commercial farming conditions to produce highest yields under irrigation (Swanevelder, 1998). Efforts were therefore initiated by the Department of Agriculture and Land Administration (DALA) during early 1990s to overcome major production constraints experienced by the smallholder sector in the Province and to enhance sustainability of their cropping systems and alleviate rural poverty. In 1995, the variety *79H1*, developed by Agricultural Research Council-Grain Crops Institute (ARC-GCI), Potchefstroom, South Africa was identified as the most acceptable variety to the smallholder farmers in Mpumalanga. The variety was selected based on its higher yield, lower yield loss to the *Alectra* parasite and farmer preferences to seed colour and taste (Beck *et al.*, 1991). Although foliar disease resistant varieties introduced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) during early 1990s had shown significant resistance, the kernel yield was low due to poor pod filling (Mathews and Beck, 1994). The studies carried out during 1993-1996 showed the yield potential of JL24 received from ICRISAT Malawi (Mathews, 1997) and it was included in the national variety list in 2000. Although *KaNgwane Red* (79H1) and JL24, are highly susceptible to foliar diseases, they have been very popular with the smallholder farmers not only in Mpumalanga, but also in Limpopo and Kwazu-Natal. Improved production practices were also successfully demonstrated in a farmer participatory programme funded by the Groundnut Development Trust, South Africa in 2000-2001 season (Mathews, 2003) and it has been successfully adopted by several farmers in the region.

Variety evaluation is a dynamic process and therefore, the quest for identifying locally adapted foliar disease resistant varieties was continued. A total of 129 elite lines / germplasm made up of replicates of International Foliar Diseases Resistant series VIII and IX, International Short-duration series VIII and IX, International Drought Resistant / Tolerant series-IV, and selected foliar diseases / rosette virus disease resistant / short-duration varieties / germplasm from ARC-GCI, Potchefstroom and ICRISAT, Malawi and eight commercially available South African cultivars were evaluated during 2000-2004. Fifteen outstanding varieties selected from these trials (DALA 2002, 2003 and 2004; Cilliers and Mathews, 2003) were subjected to further evaluations. This paper analyses the results of these variety evaluations carried out during 2004-2006.

## Materials and Methods

**Experimental sites and treatments**

Field experiments were conducted at various sites in Mpumalanga province, South Africa in 2004/2005 (Experiments I and II) and 2005/2006 (Experiments III and IV). Experiments I and II were conducted at five different sites: Mzinti (25° 41' 27" S, 31° 43' 44" E,), Malekutu (25° 16' 51" S, 31° 10' 40" E,), and Nelspruit (25° 26' 25" S, 30° 58' 57"E) in Ehalnzeni region; Elukwatini (26° 03' 06" S, 30° 49' 34" E) in Gert-Sibande region; and Kliplaatdrift (25° 15' 0" S, 29° 1' 48"E) in Nkangala region. The altitude of these sites ranged from ± 260m at Mzinti to 1060m at Kliplaatdrift. The cropping season rainfall received during 2005-06 ranged from 469 mm at Kliplaatdrift (Nkangala) to >910 mm at Nelspruit (Ehlanzeni. In comparison, the rainfall was lower during the previous season and it ranged from 423mm at Klplaatdrift to 558mm at Nelspruit. Soils at these sites are generally sandy loam except at Elukwatini (clay 24%), with pH (KCl) ranging from 5.05 at Nelspruit to 6.43 at Malekutu. Experiment I comprised five short duration and two drought tolerant lines, and JL24 as control. Experiment II consisted of seven foliar disease resistant varieties and JL24, with and without fungicide (mancozeb) application. All the treatments in Experiments I and II were laid out in a randomised complete block design (RCBD) replicated four times. The 15 genotypes evaluated in Experiments I and II were selected from earlier trials conducted in 2000-2004. In both experiments, lime was applied at a rate of 500kg $ha^{-1}$ before land preparation, 250kg $ha^{-1}$ NPK (2:3:2) was applied at planting, gypsum (500kg $ha^{-1}$) was applied to the soil surface at flowering. Three rounds of spraying (mancozeb) were given at 30, 50 and 70 Days After Planting (DAP) to JL24 in Experiment II. The plot size was two rows of 5m long with inter-row spacing of 70 cm. Seeds treated with thiram (thiulin) were planted manually at 10 cm part.

Four foliar disease resistant, two short duration and one drought tolerant genotype selected (based on seed yield, short maturity period and lower incidence of foliar diseases) from Experiments I and II were evaluated in Research Managed (Experiment III) and Farmer Managed (Experiment IV) trials. Experiment III was conducted at Alkmaar in Ehalnzeni region and the five sites that were used in Experiments I and II. Experimental design, plot sizes and cultural practices were similar to those in Experiment II. In Experiment IV the same genotypes used in Experiment III were evaluated, in a RCBD with two replications at each site, by 65 volunteer farmers (under the supervision of research / extension personnel) selected across three regions in Mpumalanga. The cultural practices and plot sizes were similar to those in Experiment III. Observations were recorded by research personnel and harvesting was done under their supervision.

**Measurements**

The following parameters were determined in all the experiments: crop establishment, crop stand at harvest, disease incidences, pod yield, seed yield, shelling percentage, 100-seed weight and days to harvest maturity. Visual scoring on diseases was recorded on a 1 to 9 scale where 1 denotes 'no disease symptoms' and 9 'severe incidence with 81-100% defoliation' (Subrahmanyam *et al.*, 1995).

**Statistical analysis**

The data obtained from the four experiments were subjected to analysis of variance (ANOVA) and Duncan's multiple comparison tests using statistical MSTAT-C (1983) software. The grain yield data from the multi-location trials carried in 2005/2006 (Experiments III and IV) were subjected to AMMI analysis to determine the yield stability of the varieties across environment (Gauch, 1992).

## Results and Discussion

The yields in general were low in Experiment I and II, as a result of inadequate rain received during the season. The joint analysis of the results from five sites in Experiment-I showed greater yield potential of all the ICRISAT varieties compared to JL24 (Table 1). The overall pod yield showed significant differences (p=0.05) between the genotypes evaluated with the highest yield being recorded for ICGVSM99529, followed by ICGV96294 (Table 1).

The variety ICGVSM99529 produced a yield of 1434 kg ha$^{-1}$ which was 52.8% greater than the pod yield realised by JL24. The varieties ICGVs 99529, 96294 and 97245 gave significantly greater pod yield than JL24 (p=0.05). A similar trend was also observed in the mean seed yield obtained by these varieties (Table 1). The variety ICGVSM99529 recorded significantly greater shelling percent than JL24 (p=0.05). The mean seed sizes were the lowest in ICGVSM99529.

**Table 1:** Performance of short-duration and drought tolerant ICRISAT groundnut varieties across five sites ( Joint analysis: Experiment I) in Mpumalanga, 2004-05

| S. No. | VARIETIES | PYH | SHP | SYH | HSM | DTM |
|---|---|---|---|---|---|---|
| 1 | ICGVSM99529 | 1434 | 65.7 | 942 | 27.2 | 124 |
| 2 | ICGV96294 | 1301 | 59.4 | 808 | 37.4 | 132 |
| 3 | ICGV97245 | 1302 | 60.3 | 802 | 32.0 | 128 |
| 4 | ICGV95278 | 1201 | 59.1 | 741 | 29.9 | 126 |
| 5 | ICGV87391 | 1177 | 58.3 | 711 | 32.0 | 126 |
| 6 | ICGV97182 | 1208 | 52.5 | 651 | 26.7 | 128 |
| 7 | ICGV99543 | 1028 | 60.0 | 624 | 33.7 | 123 |
| 8 | JL24 | 938 | 58.2 | 573 | 29.2 | 127 |
| | Mean | 1199 | 59.2 | 731 | 31.0 | 126 |
| | LSD (p=0.05) | 282 | 5.2* | 192 | 4.4 | NS |
| | CV (%) | 18.2 | 6.8 | 20.3 | 10.9 | 3.2 |

HSM` 100- seed weight ELS - Early leaf spot score LLS - Late leaf spot score
RS - Rust score. PYH: Pod yield kg ha$^{-1}$ SYH: Seed yield kg ha$^{-1}$
SHP: Shelling percentage DTM: Days to maturity NS: Not significant

Experiment II was successfully carried out only at four sites. The joint analysis of the data from these four trials showed the greater yield potential of all the introduced varieties except ICGV90099 (Table 2). The increase in pod yield was highly significant in six varieties (p=0.01). The highest pod yield of 1914 kg ha$^{-1}$ was recorded for ICGV92088 followed by ICGV93197, ICGV96262 and ICGV98369. The yield differences between these varieties were not large enough to be significant. A similar trend was observed with the seed yield of these varieties. The yield increases of the foliar disease resistant varieties over JL24 with out fungicidal spray ranged from 26.6% to 50%. In general, the shelling percentage was lower in all the varieties probably due to erratic rainfall received during cropping season. Incidences of foliar diseases were comparatively low during the season probably due to low rainfall received. All the genotypes from ICRISAT recorded significantly lower foliar disease scores than JL24 without fungicide spraying (p=0.001). Application of fungicide (mancozeb) from 30 DAP to the susceptible variety JL24 gave up to 62% yield increase at Elukwatini with an average increase of 18% across four sites. Seven varieties from the above two set of trials were selected for further evaluation based on seed yield, short maturity period and lower incidence of foliar diseases

**Table 2:** Performance of foliar diseases resistant ICRISAT groundnut varieties across four sites (Joint analysis: Experiment II) 2004-05

| S. No | VARIETIES | PYH | SHP | SYH | HSM | ELS | LLS | RS | DTM |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ICGV92088 | 1914 | 60.5 | 1180 | 33.3 | 2.4 | 1.5 | 1.6 | 143 |
| 2 | ICGV93197 | 1889 | 60.3 | 1157 | 37.2 | 2.9 | 2.2 | 2.0 | 136 |
| 3 | ICGV96262 | 1687 | 61.3 | 1052 | 28.9 | 2.4 | 1.7 | 1.7 | 139 |
| 4 | ICGV98369 | 1783 | 58.0 | 1006 | 30.2 | 2.4 | 1.6 | 1.6 | 141 |
| 5 | ICGV98370 | 1719 | 57.5 | 999 | 31.5 | 2.0 | 1.5 | 1.4 | 139 |
| 6 | ICGV98371 | 1644 | 60.3 | 993 | 31.4 | 2.3 | 1.6 | 1.7 | 136 |
| 7 | JL24 + spray | 1394 | 64.6 | 933 | 34.1 | 2.4 | 1.8 | 1.9 | 134 |
| 8 | ICGV90087 | 1510 | 60.0 | 922 | 33.8 | 1.7 | 1.0 | 1.1 | 145 |
| 9 | ICGV90099 | 1033 | 47.8 | 506 | 24.7 | 2.0 | 1.2 | 1.2 | 145 |
| 10 | JL24 control | 1188 | 64.1 | 789 | 32.0 | 4.8 | 3.9 | 4.4 | 131 |
| | Mean | 1566 | 59.4 | 954 | 31.7 | 2.5 | 1.8 | 1.9 | 138 |
| | LSD (P=0.05) | 433 | 5.4 | 324 | 3.5 | 0.61 | 0.41 | 0.43 | 6.6 |
| | CV (%) | 19.0 | 6.3 | 23.4 | 7.6 | 14.2 | 13.4 | 13.4 | 3.3 |

In the Experiment III (RM Trials), the joint analysis of the data from across six sites showed that all the selected varieties except ICGV93197 had significantly (p=0.05) greater seed yield than the unsprayed JL24 (Table 3). The highest mean seed yield of 1576 kg ha$^{-1}$ was recorded in the short-duration variety ICGVSM99529 followed by the foliar disease resistant variety ICGV98369 (1410 kg ha$^{-1}$). The yield increase in ICGVSM99529 was significantly higher (p=0.05) than all the other varieties except ICGV98369. JL24 and ICGV98369 were the most stable varieties, followed by ICGV96294, as seen from the AMMI analysis (Fig 2). The yield differences among the varieties ICGVs 98369, 96294, 96262, 97245 and 92088 were not large enough to be significant. Significant differences (p=0.05) were observed between varieties for all three foliar diseases evaluated (Table 3). Foliar disease scores were significantly lower in all the resistant varieties. However, the resistant varieties started to show symptoms of LLS towards the end of the growing period, after 120 DAP. The short-duration varieties ICGV97245 and ICGVSM99529 were highly susceptible to foliar diseases especially to LLS. Application of three rounds of mancozeb increased seed yield of the susceptible variety JL24 up to 32 % at Malekutu, with a mean increase of 16.5% across five sites. ICGVSM99529 recorded the highest shelling percent of 74.9%, which was significantly higher than for JL24 (p=0.05).

**Table 3:** Performance of selected ICRISAT groundnut varieties across six sites in Mpumalanga, (Joint analysis: Experiment III / RM Trials) 2005-06)

| S. No. | VARIETIES | PYH | SHP | SYH | HSM | ELS | LLS | RS |
|---|---|---|---|---|---|---|---|---|
| 1 | ICGVSM 99529 | 2084*a* | 74.9*a* | 1576*a* | 32.0*ef* | 3.3*b* | 5.4*a* | 3.7*b* |
| 2 | ICGV 98369 | 2114*a* | 65.9*de* | 1410*ab* | 35.1*bc* | 2.6*cd* | 2.3*c* | 1.7*de* |
| 3 | ICGV 96294 | 1911*abc* | 69.1*bc* | 1351*bc* | 38.7*a* | 3.1*bc* | 3.7*b* | 2.5*cd* |
| 4 | ICGV 96262 | 1956*ab* | 65.9*de* | 1303*bc* | 31.0*f* | 2.5*d* | 2.4*c* | 1.7*de* |
| 5 | ICGV 97245 | 1764*bc* | 71.5*bc* | 1278*bc* | 38.2*a* | 3.1*bc* | 4.7*a* | 3.4*b* |
| 6 | ICGV 92088 | 1858*abc* | 64.5*e* | 1218*bc* | 33.7*cde* | 2.6*cd* | 2.1*c* | 1.6*e* |
| 7 | ICGV 93197 | 1768*bc* | 65.3*e* | 1168*cd* | 37.0*ab* | 2.9*bcd* | 3.8*b* | 2.3*de* |
| 8 | JL 24 with fungicide | 1667*cd* | 69.2*bc* | 1165*cd* | 34.5*cd* | 3.2*b* | 3.7*b* | 3.3*bc* |
| 9 | JL 24 no fungicide | 1445*d* | 68.3*cd* | 1002*d* | 32.7*def* | 4.4*a* | 5.4*a* | 4.7*a* |
| Mean | | 1841 | 68.2 | 1274 | 34.7 | 3.1 | 3.7 | 2.8 |
| LSD (p=0.05) | | 264 | 2.7 | 199 | 2.3 | 0.60 | 0.88 | 0.86 |
| CV (%) | | 12.3 | 3.3 | 134 | 5.6 | 16.6 | 20.4 | 26.7 |

*Means within columns followed by the same letter do not differ significantly at p≤0.05 (LSD) Almost a similar trend in all the parameters studied was observed in the Experiment IV (FM trials) carried out successfully at 50 sites across the province. The combined analysis of the data from across 50 sites showed that the ICRISAT genotypes had greater yield potential than JL24 confirming the findings from the RM trials (Table 4). The increase in yield was significantly greater than JL24 in all the varieties except ICGV93197 and ICGV97245 (p=0.05). ICGV98369 recorded the highest seed yield of 1728 kg $ha^{-1}$ followed by ICGVSM99529 with 1641 kg $ha^{-1}$ and increase was 26.6% in ICGV98369 and 20.3% in ICGVSM99529 over JL24. The average seed yield obtained from three irrigated sites in Ehlanzeni was 3024 kg $ha^{-1}$, and under dry land, it varied from 1172 kg $ha^{-1}$.in Ehalanzeni region to 2181 kg $ha^{-1}$ in the Nkangala region. The overall mean yield of 1547 kg $ha^{-1}$ recorded for the 50 sites was greater than the national average of 1200 kg $ha^{-1}$ obtained by the commercial sector in South Africa. The yield potential of ICGV98369 was evident when the highest yielding variety per farm was picked based on AMMI analysis. ICGV98369 was the top yielder at 20 sites followed by ICGVSM99529 with the highest yield at 16 sites. The varieties JL24 and ICGV96294 were the most stable varieties based on AMMI analysis and ICGV97245 was found to be the least stable in Experiment IV (Fig 3). The variety ICGVSM99529 gave the highest yield at Kliplaatdrift (Nkangala region) where the rainfall during the season (469 mm) was comparatively lower than the amount recorded (910mm) in Ehlanzeni region. ICGV98369 was ready for harvest from 138-143 DAP compared to 123-127 days required for JL24. In Ehlanznei, with longer growing period facilitated by higher rainfall received during the season, the foliar diseases resistant variety ICGV98369 with longer maturity period gave the greatest yield. ICGVSM99529 recorded significantly (p=0.05) higher shelling percent and was ready for harvest 3-5 days earlier than JL24. ICGV98369 recorded lower disease scores of <3 showing resistance to the foliar diseases complex of early and late spots and rust under local environment (Fig 1). In general, the incidence of leaf spots was higher during 2005-2006 season in Nsikazi area and sites where groundnut was grown under irrigation probably as a result of environment (temperature, rainfall and humidity) favorable to disease infection and development (McDonald *et al.*, 1985). The LLS started to appear towards the end of the season about 120 DAP in all the foliar diseases resistant lines without causing any defoliation up to the time of harvest.

Resistance to leaf spot diseases is a desirable trait because premature defoliation reduces both the seed yield and the amount of hay that can be fed to livestock. Apart from this, several *Cercospora* species produce a red-coloured, non-specific toxin called cercosporin (Balis and Payne, 1971; Fore *et al.*, 1988), which could be harmful to livestock. Although chemical control has given yield increase of 10-62% in the current studies, it is not a viable solution for the smallholder farmers.

**Table 4:** Performance of selected ICRISAT groundnut varieties across fifty sites in Mpumalanga, (Joint analysis: Experiment IV / FM Trials) 2005-06)

| S. No. | VARIETIES | PYH | SHP | SYH | ELS | LLS | RS |
|---|---|---|---|---|---|---|---|
| 1 | ICGV98369 | 2479*a* | 68.9*b* | 1728*a* | 2.8*d* | 2.3*de* | 1.7*f* |
| 2 | ICGVSM99529 | 2190*bc* | 74.2*a* | 1641*a* | 4.2*b* | 6.6*a* | 4.9*b* |
| 3 | ICGV96294 | 2335*ab* | 68.8*b* | 1617*a* | 3.2*c* | 4.2*b* | 3.2*d* |
| 4 | ICGV96262 | 2335*ab* | 68.6*b* | 1611*a* | 2.8*d* | 2.6*cd* | 2.2*e* |
| 5 | ICGV92088 | 2338*ab* | 68.0*bc* | 1603*a* | 2.7*d* | 2.1*e* | 1.8*f* |
| 6 | ICGV93197 | 2214*bc* | 64.2*d* | 1440*b* | 2.9*d* | 2.8*c* | 2.0*ef* |
| 7 | ICGV97245 | 2002*cd* | 67.3*c* | 1377*b* | 3.5*c* | 4.5*b* | 4.1*c* |
| 8 | JL24 | 1943*d* | 68.9*b* | 1364*b* | 4.8*a* | 6.9*a* | 5.3*a* |
| Mean | | 2229 | 68.6 | 1548 | 3.4 | 3.4 | 3.1 |
| LSD (P=0.05) | | 215 | 1.5 | 163 | 0.22 | 0.22 | 0.35 |
| CV (%) | | 24.6 | 5.5 | 26.7 | 14.1 | 14.1 | 24.3 |

Kernel yield is the most important factor to be considered in the selection of a new variety for the smallholder farmers since most of the produce is either consumed in the household or sold at local markets. The greater seed yield recorded in the small seeded variety ICGVSM99529 may be attributed to higher shelling percent. The shorter maturity period may also have facilitated greater seed yield in this variety, especially in the drought prone areas like the Nkangala region. Maize which is the major component of the local cropping systems frequently fails to give reasonably good yield due to inadequate rainfall and other stresses. Groundnut is capable of withstanding this harsh environment to a great extend and hence may give more satisfactory seed yield. It can therefore be a good security crop for this region as shown in the current study. Therefore, it is possible that identification, selection and release of adapted varieties may encourage smallholder farmers to bring additional land under groundnut production in the Province.

**Figure 1: Groundnut variety (FM) trials, Mpumalanga, South Africa, 2005-06**
**Mean disease (ELS, LLS and RS) scores across 50 sites**

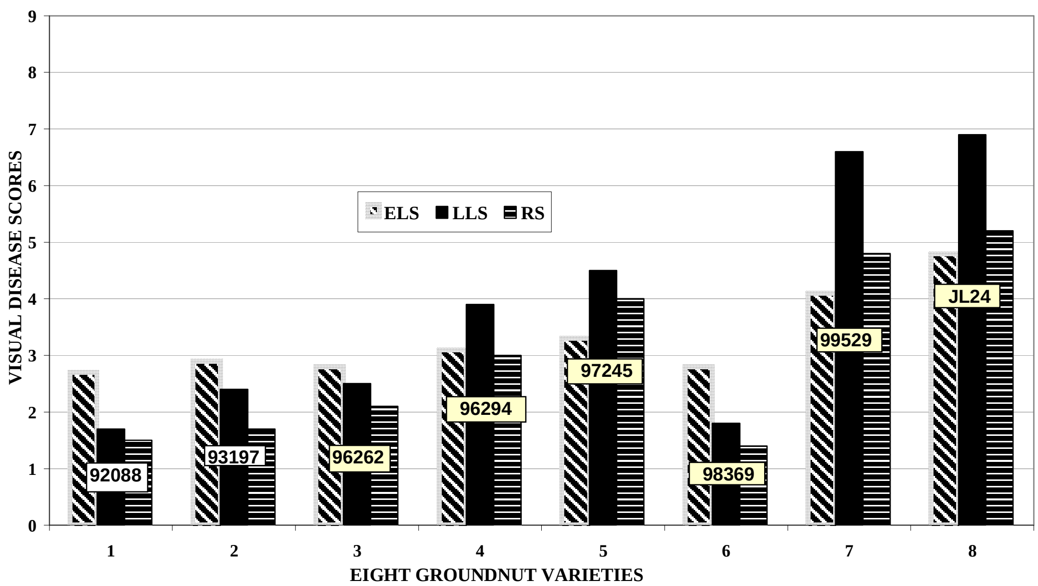


**Figure 2: Groundnut variety (RM) trials, Mpumalanga, South Africa, 2005-06: Stability analysis: Genotype means and PCA1 (AMMI) scores, (seed yield kg/ha)**

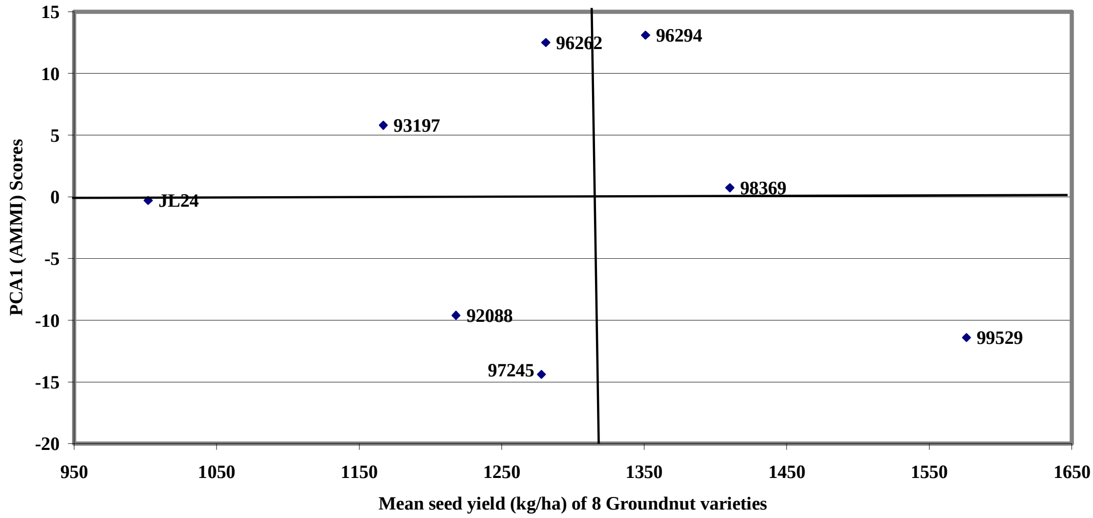
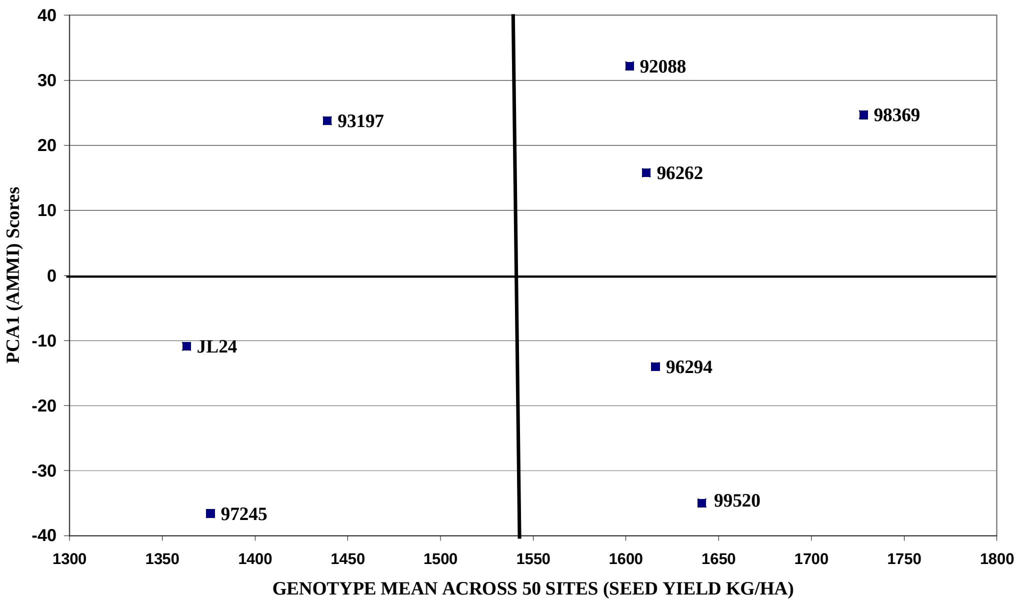



**Figure 3: Groundnut vareity (FM) trials, Mpumalanga, South Africa, 2005-06 Stability analysis: Genotype means and PCA1 (AMMI) scores,(seed yield kg/ha)**




## Conclusion

Based on the higher and stable kernel yield, adaptability, resistance to the foliar disease complex and shorter maturity period, the varieties ICGVSM99529 and ICGV98369 from ICRISAT were identified as the most outstanding. The variety ICGV96294 was also promising based on its yield stability and yield potential similar to that of ICGV98369. It is expected that introduction of these varieties to the smallholder cropping systems would contribute immensely towards sustainability of their cropping systems and help alleviate rural poverty and malnutrition. The results from these studies would also benefit the farming communities under similar environment in other provinces across South Africa. It is suggested that planting more than one variety with diverse growth characteristics would further enhance stability of cropping systems especially under unpredictable weather conditions.

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